CLAIMS

1. A method for forming silicon dioxide (SiO2) on a silicon carbide (SiC) substrate, the method comprising:

providing a SiC substrate;

supplying an atmosphere including oxygen;

performing a high-density (HD) plasma-based process; and,

forming a SiO2 layer overlying the SiC substrate.

2. The method of claim 1 wherein performing an HD plasma-based process includes connecting a top electrode to an inductively coupled HD plasma source.

3. The method of claim 2 wherein performing an HD plasma-based process includes:

performing an HD plasma oxidation process:

in response to the HD oxidation process, creating a reactive oxygen species;

breaking the Si-C bonds in the SiC substrate, to form free Si and C atoms in the SiC substrate; and,

wherein forming a SiO2 layer overlying the SiC substrate includes bonding the free Si atoms in the SiC substrate to the HD plasma-generated reactive oxygen species, and growing the SiO2 layer.

4. The method of claim 3 wherein providing a SiC substrate includes maintaining the SiC substrate at a temperature of 360 degrees C, or less.

5. The method of claim 3 wherein supplying an atmosphere including oxygen includes supplying O2 with an inert gas, where the ratio of inert gas to O2 is in the rage between 10:1 and 200:1.

6. The method of claim 5 wherein supplying the O2 with an inert gas includes using an inert gas selected from the group including He, Kr, and Ar.

7. The method of claim 3 wherein performing an HD plasma-based process further includes bonding the free C atoms in the SiC substrate with the reactive oxygen species, forming carbon monoxide (CO); and

the method further comprising:

removing the CO from the process.

8. The method of claim 3 wherein supplying an atmosphere including oxygen includes supplying a pressure of up to 500 milliTorr (mTorr), with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, and a total gas flow of approximately 50 to 200 standard cubic centimeters per minute (sccm); and,

wherein performing a HD plasma-based oxidation process includes:

locating the SiC substrate between a bottom electrode and the top electrode;

supplying a power density of up to 10 watts per square centimeter (W/cm^2), at a frequency in the range of 13.56 to 300 megahertz (MHz), to the top electrode; and,

supplying a power density of up to 3 W/cm^2, at a frequency in the range of 50 kilohertz (KHz) to 13.56 MHz, to the bottom electrode.

9. The method of claim 3 wherein supplying an atmosphere including oxygen includes supplying a He/O2 atmosphere; and,

wherein forming a SiO2 layer overlying the SiC substrate includes forming a SiO2 layer at deposition rate of about 100 Å, in 10 minutes.

10. The method of claim 2 wherein supplying an atmosphere including oxygen includes supplying SiH4, N2O, and N2;

wherein performing an HD plasma-based process includes:

performing an HD plasma enhanced chemical vapor deposition (PECVD) process; and,

in response to the HD PECVD process, causing a reaction between the gases in the atmosphere; and,

wherein forming a SiO2 layer overlying the SiC substrate includes depositing a SiO2 layer over the SiC.

11. The method of claim 10 providing a SiC substrate includes maintaining the SiC substrate at a temperature of 400 degrees C, or less.

12. The method of claim 10 wherein supplying SiH4, N2O, and N2 includes supplying SiH4, N2O, and N2 in a ratio of 10-25:100:50.

13. The method of claim 10 wherein supplying an atmosphere including oxygen includes maintaining an atmosphere pressure in the range of 10 to 500 mTorr.

14. The method of claim 10 wherein supplying an atmosphere including oxygen includes supplying a pressure of up to 500 mTorr, with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, and a total gas flow of approximately 50 to 200 sccm; and,

wherein performing a HD PECVD process includes:

locating the SiC substrate between a bottom electrode and the top electrode;

supplying a power density of up to 10 W/cm^2, at a frequency in the range of 13.56 to 300 MHz, to the top electrode; and,

supplying a power density of up to 3 W/cm^2, at a frequency in the range of 50 KHz to 13.56 MHz, to the bottom electrode.

15. The method of claim 10 wherein forming a SiO2 layer overlying the SiC substrate includes forming a SiO2 layer having a bias temperature stress (BTS) of less than 1 volt, at 150 degrees C, with a bias voltage of +/- 2 megavolts per centimeter (MV/cm).

16. The method of claim 10 wherein forming a SiO2 layer overlying the SiC substrate includes forming a SiO2 layer having a breakdown strength of greater than 10 MV/cm.

17. The method of claim 10 wherein forming a SiO2 layer overlying the SiC substrate includes forming a SiO2 layer having a leakage current density of less than 1 x 10^{-7} amps per square centimeter (A/cm^2), at an applied field of 8 MV/cm.

18. The method of claim 10 providing a SiC substrate includes maintaining the SiC substrate at a temperature of 150 degrees C, or less.

19. The method of claim 2 further comprising:

prior to the HD plasma-based process, depositing a Si layer overlying the SiC substrate;

wherein performing an HD plasma-based process includes:

performing an HD oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species;

wherein forming a SiO_2 layer overlying the SiC substrate includes bonding Si atoms in the Si layer to the reactive oxygen species, growing a SiO_2 layer overlying the Si layer.

20. The method of claim 19 wherein depositing a Si layer overlying the SiC substrate includes depositing a Si layer selected from the group including amorphous Si, polycrystalline Si, and single-crystal Si.

21. The method of claim 19 providing a SiC substrate includes maintaining the SiC substrate at a temperature of 400 degrees C, or less.

22. The method of claim 19 wherein supplying an atmosphere including oxygen includes supplying a pressure of up to 500 mTorr, with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, and a total gas flow of approximately 50 to 200 sccm; and,

wherein performing a HD oxidation process includes:

locating the SiC substrate between a bottom electrode and the top electrode;

supplying a power density of up to 10 W/cm^2, at a frequency in the range of 13.56 to 300 MHz, to the top electrode; and,

supplying a power density of up to 3 W/cm^2, at a frequency in the range of 50 KHz to 13.56 MHz, to the bottom electrode.

23. The method of claim 22 wherein supplying a pressure of up to 500 mTorr, with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, includes mixing oxygen with inert gas selected from the group including helium, argon, and krypton.

24. The method of claim 2 further comprising:

depositing a Si layer;

wherein performing an HD plasma-based process includes:

initially performing an HD oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species;

wherein performing an HD plasma-based process includes:

subsequently performing a HD PECVD process;

in response to the HD PECVD process, causing a reaction between gases in the atmosphere;

wherein supplying an atmosphere including oxygen includes, with respect to the PECVD process, supplying SiH4, N2O, and N2;

wherein forming a SiO2 layer overlying the SiC substrate includes a combination of growing and depositing a SiO2 layer over the Si layer.

25. The method of claim 24 wherein depositing a Si layer overlying the SiC substrate includes depositing a Si layer selected from the group including amorphous Si, polycrystalline Si, and single-crystal Si.

26. The method of claim 24 providing a SiC substrate includes maintaining the SiC substrate at a temperature of 400 degrees C, or less.

27. The method of claim 24 wherein supplying an atmosphere including oxygen includes supplying a pressure of up to 500 mTorr, with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, and a total gas flow of approximately 50 to 200 sccm; and,

wherein performing a HD oxidation process includes:

locating the SiC substrate between a bottom electrode and the top electrode;

supplying a power density of up to 10 W/cm^2, at a frequency in the range of 13.56 to 300 MHz, to the top electrode; and,

supplying a power density of up to 3 W/cm^2, at a frequency in the range of 50 KHz to 13.56 MHz, to the bottom electrode.

28. The method of claim 27 wherein supplying a pressure of up to 500 mTorr, with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, includes mixing oxygen with inert gas selected from the group including helium, argon, and krypton.

29. The method of claim 24 wherein supplying SiH4, N2O, and N2 in the HD PECVD process includes supplying SiH4, N2O, and N2 in a ratio of 10-25:100:50.

30. The method of claim 29 wherein supplying an atmosphere including oxygen includes supplying a pressure of up to 500 mTorr, with a mixture of inert gas and oxygen in a ratio of approximately 10:1 to 200:1, and a total gas flow of approximately 50 to 200 sccm; and,

wherein performing a HD PECVD process includes:

locating the SiC substrate between a bottom electrode and the top electrode;

supplying a power density of up to 10 W/cm^2, at a frequency in the range of 13.56 to 300 MHz, to the top electrode; and,

supplying a power density of up to 3 W/cm^2, at a frequency in the range of 50 KHz to 13.56 MHz, to the bottom electrode.

31. The method of claim 2 wherein performing an HD plasma-based process includes:

performing an HD oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species;

wherein forming a SiO2 layer overlying the SiC substrate includes bonding the free Si atoms in the SiC substrate to the HD plasma-generated reactive oxygen species, and growing the SiO2 layer;

the method further comprising:

etching the SiO2 layer, exposing a region of the SiC substrate; and,

depositing a metal in the exposed region of SiC substrate to form a metal-semiconductor contact.

32. A method for growing silicon dioxide (SiO2) on a silicon carbide (SiC) substrate, the method comprising:

providing a SiC substrate at a temperature of 360 degrees C, or less;

supplying an atmosphere including oxygen;

performing a high-density (HD) plasma oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species;

breaking the Si-C bonds in the SiC substrate, to form free Si and C atoms in the SiC substrate; and,

bonding the free Si atoms in the SiC substrate to the HD plasma-generated reactive oxygen species, and growing the SiO2 layer.

33. A method for depositing silicon dioxide (SiO2) on a silicon carbide (SiC) substrate, the method comprising:

providing a SiC substrate at a temperature of 400 degrees C, or less;

supplying an atmosphere including SiH4, N2O, and N2;

performing a high-density (HD) plasma enhanced chemical vapor deposition (PECVD) process;

in response to the HD PECVD process, causing a reaction between the gases in the atmosphere; and,

depositing a SiO2 layer over the SiC.

34. A method for growing silicon dioxide (SiO_2) on a Si/silicon carbide (SiC) structure, the method comprising:

providing a SiC substrate at a temperature of 400 degrees C, or less;

depositing a layer of Si overlying the SiC;

supplying an atmosphere including oxygen;

performing a high-density (HD) oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species; and,

bonding Si atoms in the Si layer to the reactive oxygen species, growing a SiO_2 layer overlying the Si layer.

35. A method for forming silicon dioxide (SiO_2) on a Si/silicon carbide (SiC) structure, the method comprising:

providing a SiC substrate at a temperature of 400 degrees, or less;

depositing a Si layer overlying the SiC;

supplying an atmosphere including oxygen;

initially performing a high-density (HD) oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species;

subsequently performing a HD PECVD process;

in response to the HD PECVD process, causing a reaction between SiH_4, N_2O, and N_2 gases in the atmosphere;

forming a SiO2 layer overlying the Si layer by a combination of growing and depositing SiO2 layer.

36. A method for forming a Schottky contact on a silicon carbide (SiC) substrate, the method comprising:

providing a SiC substrate;

supplying an atmosphere including oxygen;

performing a high-density (HD) oxidation process;

in response to the HD oxidation process, creating a reactive oxygen species;

bonding the free Si atoms in the SiC substrate to the HD plasma-generated reactive oxygen species, and growing an SiO2 layer;

etching the SiO2 layer, exposing a region of the SiC substrate; and,

depositing a metal in the exposed region of SiC substrate to form a metal-semiconductor contact.